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Proposal to
Department of Defense
covering

Conversion of Navy DAQ Direction Finder System
to
Transportable Shore System



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[Redacted]

DEC 4 1951

TABLE OF CONTENTS

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	<u>Page</u>	
PART I - PROBLEM	1	
PART II - DESCRIPTION OF SYSTEM	1	
PART III - THEORY OF OPERATION	1, 2	
PART IV - UNITS TO BE SUPPLIED	2	
PART V - APPLICABLE SPECIFICATIONS	2, 3	
PART VI - WHAT [Redacted] PROPOSE TO SUPPLY	3	50X1
A. General Statement	3, 4	
B. Difference Navy/Dept. Defense Requirements	4	
C. Present Situation	4	
D. Specific Proposal	4, 5	
E. Delivery	5	
F. Estimated Costs	5	

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PART I - PROBLEM:

The project involves modifying and/or adding to existing direction finding equipment. The existing equipment is known as the Navy 'Model DAQ High Frequency Radio Direction Finder System'.

The Navy DAQ equipment was originally designed for shipboard installations; whereas, the Department of Defense application requires it to be an easily transportable shore system. Thus, the project involves omitting those parts of the system which are peculiar to shipboard installations and substituting in their place parts which meet the particular requirements of a shore direction finding system.

PART II - DESCRIPTION OF SYSTEM:

Briefly, the system includes an elaborate antenna array with its junction boxes, a goniometer to properly connect the antenna array to the receiver, the receiver itself and its associated power supply and finally a cathode ray tube indicator. All of the original Navy Model DAQ equipment is useful for shore type installations where transportability is required with the exception of the antenna array and its junction boxes.

Shipboard installations employ an antenna array known as 'Crossed-Loop and Sense Antenna' designed for mounting on the mast of a ship.

Shore installations would not employ such shipboard antenna systems because of the greater gain and accuracy that can be obtained by other antenna types not applicable for shipboard use (principally because of their physical size).

A suitable shore-type antenna system employs five vertical antenna masts for each of two arrays. Two arrays of five masts each, are required in order to provide the efficiency required of shore systems over the frequency range to be covered. The vertical mast elements are arranged so that one is at each corner of a square and the fifth is located at the center of the square.

PART III - THEORY OF OPERATION

In operation, the radio signal whose originating direction is to be measured is received on the four masts identified as the North mast and its diagonally opposite South mast; and the East mast and its diagonally opposite West mast.

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If the radio signal is from the North, it is first received on the North mast and then on the South mast. By properly connecting the outputs of these two masts together, and because these masts are in line with the path of the radio signal, they combine in their outputs to yield a strong signal at the receiver. The same signal is also received on the East and West masts at precisely the same time. Because the East and West masts are at right angles to the North and South masts, and because of their spacing and connections, the output of the East mast cancels the output of the West mast, therefore, no output from that pair of masts reaches the receiver. A goniometer (the goniometer serves to apply the outputs of the four masts to the receiver) is mechanically coupled to the receiver indicator so that the display of signals on the cathode ray tube are arranged for the operator to identify the direction from the signals originate.

The display of information on the screen of the cathode ray tube yields a long thin figure of eight centered on the tube and pointing exactly up and down. This (in the above example) would inform a trained operator that the radio signal is arriving from exactly North or exactly South. In order to remove this ambiguity, the fifth vertical mast at the center is connected into the receiver indicator in such a way as to cancel the energy contributed by the mast most distant from the received direction (in this case the South mast) and the display would then appear as a finger pointing from the center of the cathode ray tube directly 'up' which is North. The display tube has marking around its outer edge corresponding to the standard compass markings (ie: N. E. S. and W 0 to 360 degrees).

PART IV - UNITS TO BE SUPPLIED:

Thus, the real problem here is to provide the vertical mast antenna arrays and their connecting means to an existing receiving system, in such a way as to provide transportability and the accuracy required.

One of the problems involves the transportability feature. All masts and other parts of the system must be packed in carrying cases so that they may be 'dumped' on a beach and hand carried to the shore location. The cases are then to be opened by hand (without tools) and the entire system set up in five man hours per antenna array, with two men familiar with the equipment.

Not only must such transit cases be provided for the antenna masts, but for all of the other units making up the entire assembly (power supply units, receivers, indicators, goniometers, cabling and other accessories necessary for the installation).

PART V - APPLICABLE SPECIFICATIONS:

The U.S. Navy, Bureau of Ships Specification No. A-464, dated 1 May 1951, describes all of the requirements, and inasmuch as the Department of Defense has access to it, it will not be included herein.

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The critical points will, however, be discussed here. The monopole masts will be of two types. Type I (Low Frequency Array) will be 28 feet long or tall when erected. The type II (High Frequency Array) will be 17 feet long or tall when erected. All masts shall be designed to have a maximum collapsed length of 14.5 feet. Tripod supports will be provided for each mast, and counterpoise screens will be provided for each individual monopole mast. When erected, the masts shall have diagonal spacings as follows:

Type I - 36 feet

Type II- 16 feet

The low frequency range (Type I) arrays shall operate over the frequency range of 1.5 to 7.5 Mc. The high frequency (Type II) arrays shall operate over the frequency range of 7.5 to 30 Mc.

The ratio of maximum response to the minimum response of the antenna arrays shall be at least 30 db.

The accuracy shall be such that the uncalibratable error shall not exceed + 3 degrees over the frequency range of 1.5 to 22 Mc. This error may be greater over the range of 22.0 to 30.0 Mc.

The transit cases shall have dimensions no greater than the following:

Cases for array monopoles		Other cases
length	15 feet	39 inches
width	12 inches	22 inches
height	12 inches	17 inches

No case to exceed 200 lbs. when packed for transportation.

The temperature range shall be -40 degrees centigrade to +50 degrees centigrade.

PART VI - WHAT

PROPOSE TO SUPPLY:

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A. General Statement

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[redacted] the Bu. Ships, U.S.N.
Contract No. NObsr-52724, dated 27 June 1951. This Navy contract describes a similar project where the contractor is to convert Model DAQ equipment to transportable shore direction finding equipment.

The above mentioned contract provides for the contractor to 'use his best efforts to conduct with dispatch the work specified'.

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It is our intent that, inasmuch as the government has already provided for the costs of development work, no such charges would be necessary or included for similar work for another agency. Any costs submitted will, therefore, not include research and development on similar items, but rather only costs incidental to the actual supplying of additional items where they are similar.

B. Differences Navy/Department Defense Requirements

The requirements of the Department of Defense differ in two ways.

First: Where the Navy uses a separate receiver/indicator for each high frequency array and each low frequency array; the Department of Defense intends to use one for both arrays. This will necessitate engineering and supplying a suitable rapid switching device.

Second: The Department of Defense urgently requires three systems at the earliest possible date. This means that it may be necessary to substitute materials and improvisations in order to deliver a workable system in anything short of six months. This may also entail some re-design and application engineering to accomplish.

C. Present Situation

A design of vertical monopole has been completed which meets the Navy requirements. A model has been made, tested and found satisfactory.

A design of a toroidal transformer, which mounts at the base of the monopole to connect to the cabling, is in process. It does not yet meet the requirements, but we believe the solution is near.

All other phases are apparently solved.

D. Specific Proposal

Three Model DAQ Receiving and Indicating Equipments, complete with all accessories are to be provided to the contractor by the Department of Defense.

The Department of Defense is also to supply 9,000 feet of RG/24u Cable.

proposes to supply such engineering, model shop facilities, testing, materials and other essentials necessary to convert these three sets to three transportable shore direction finding systems as follows:

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- Item 1. Three high frequency antenna arrays each consisting of five monopoles complete with coupling units, junction boxes, transit cases, instruction manuals, ground screens and spare parts.
 - Item 2. Three low frequency antenna arrays each consisting of five monopoles complete with coupling units, junction boxes, transit cases, instruction manuals, ground screens and spare parts.
 - Item 3. Three devices to switch outputs of either high or low frequency arrays to a single goniometer. (This may be in the form of coaxial switches each device consisting of two six pole coaxial switching elements).
 - Item 4. Three sets of spare parts in accordance with JAN-P-658 Specs.
 - Item 5. Three sets of antenna orientation equipment consisting of suitable compass and sighting arrangement, plumb bobs and steel chains for laying out antenna site.
 - Item 6. Transit cases for entire equipment other than those supplied under Items 1,2,3 and 4.

E. Delivery

It is anticipated that 60 to 90 days from the receipt of a contract would be required to ship one each of the six items comprising one complete system.

Remaining units would be shipped in an additional 30 60 days.

Contractor would require suitable material priorities and allocations from N.P.A. or Department of Defense, necessary to meet these delivery dates.

F. Estimated Costs

is not able to quote firm fixed prices at this time. The work could, therefore, only be undertaken on a Cost Plus a Fixed Price basis. It is estimated that a variance of + 25% may be expected.

Estimated Costs Follow:

Items 1 through 6.

Direct Labor	\$ 11,466.50
Overhead	10,319.85
Materials (Direct)	18,000.00
Site Test Facilities	500.00
Spare Parts	4,500.00
Total Costs	44,786.35
Res (7%)	3,135.04
Total Estimate	\$ 47,921.39

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